# Adsorption of direct dye brown MR from aqueous solutions by vegetable waste.

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## Abstract

The effectiveness of adsorption for dye removal from wastewaters has made it an ideal alternative to other expensive treatment options. Removal of direct dye direct Brown MR (BMR) from an aqueous solution by Langeria Siceraria seed hull (LSH) was investigated. Kinetic and isotherm studies were carried out by considering the effects of various parameters, as different adsorbant dose, contact time, pH (2–13). It was found that the dye uptakes were much higher in acidic solutions than those in neutral and alkaline conditions. Langmuir, Freundlich, and Temkin isotherms were used to analyze the equilibrium data at different concentration. The Freunlich isotherm fits the experimental data significantly better than the other isotherm.

**Keywords:** direct dye, adsorption, colour removal, isotherm

## 1.Introduction

Textile industries have shown a significant increase in the use of synthetic complex organic dyes as colouring materials [1]. Different processes for colour removal typically include physical, chemical and biological schemes. Some processes, such as electrochemical techniques and ion pair extraction, are relatively new for textile waste treatment, while others have been used in the industry for a long time. Adsorption has been found to be superior to other techniques for water re-use in terms of initial cost, simplicity of design, use of operation and insensitivity to toxic substances [2]. Adsorption has been used extensively in industrial process for separation and purification. The removal of coloured and colourless organic pollutants from industrial wastewater is considered as an important application of adsorption processes [3].At the present, there is a growing interest in using low cost, commercially available materials for the adsorption of dyes. A wide variety of materials such as peat [4], various silicas [5], activated clay [6], plum kernels [7], chitin [8], peat [9], natural clay [10], boiler bottom ash [11], bagasse pith [12], orange peel [13], banana pith [14], tea leaves [15], pea shells charcoal [16], saw dust [17,18], rice husk ash [19,20], perlite [21], chitosan [22], eichhornia ash [23], bagasse fly ash [24], lemon peel [25], bottom ash [26], sun flower seed hull [27] etc as adsorbents for the removal of dyes from wastewaters. Critical reviews of low cost adsorbents for waste water treatment are available [28-30].

The present study investigates the adsorption of Brown MR (BMR) on a naturally occurring cheaper source of adsorbent, namely, Langeria Siceraria seed hull (LSH) , which is available in plenty in India. Various parameters affecting the adsorption have been studied. Data have been fitted to Freundlich, Langmuir and Temkin adsorption isotherms. Isotherm constants are calculated and discussed.

## 2. Materials and methods

### 2.1 Preparation of adsorbent

The Langeria Siceraria seed (vegetable waste) is cleaned manually so as to remove the soils and dust deposited over the surface of the seed hull is removed manually. Langearia Siceraria seed hull was rinsed in the cold water two or three times and then it was dried under the direct sun light for about 2 days in order to dry it completely without leaving any moisture content present in it. If moisture content presents in it, then the formation of fungus may happen, unavoidably. So it is very much essential to completely dry the seed hull under the natural, direct sunlight for a plenty of time. After 2 days the hull is taken out and again cleaned manually so as to remove the dust deposited over the surface of the seed hull.

Then this purified seed hull is taken to the further chemical activation process.

## 2.2 Preparation of adsorbate

The stock solution of direct dye brown MR was prepared by weighing 1 gm of dye accurately and dissolved in100ml of double distilled water and made upto 1000ml. Experimental solution of the desired concentration was obtained by successively dilutions. Dye concentration was determined by using absorbance values measured before and after the treatment, at 420 nm with Elico UV Visible Spectrometer (Model No.: SL 150).

2.3 Batch Experiments.

### 2.3.1 Adsorption experiment

In each adsorption experiment, 50 ml of dye solution of known concentration and pH was added to 750 mg of adsorbents in 250 ml round bottom flask at room temperature (29 + 1 °C) and the mixture was stirred on a rotary orbital shaker at 180 rpm.

### 2.3.2 Effect of adsorbent dose

The effect of the adsorbent dose on the equilibrium uptake of 50 ml of concentrations of dye 100 $mg.L^{-1}$ was investigated by agitating with different doses of adsorbent 0.1-0.6 g for a time greater than their equilibrium time at 180 rpm at their natural pH.

### 2.3.3 Effects of pH

The effect of pH on the equilibrium uptake of the dye was investigated by using 50 ml of dye solution of concentration 100 $mg.L^{-1}$) and .75gm of the adsorbent. The initial pH values were adjusted with 0.1 M HCl or 1 M NaOH to attain a pH ranging from 2-12. The suspensions were agitated for time intervals greater than the equilibrium time After agitation time, the adsorbent and adsorbate were separated by centrifugation and the supernatant was estimated spectrophotometrically.

## 3 RESULTS AND DISCUSSION

### 3.1 Effect of pH

Because the initial pH of solution can significantly influence adsorption of dyes, the effects of pH on dye adsorption on the Langeria Siceraria seed hull was studied. The value of pH used ranged from 2 to 12. As elucidated in Fig. 1, the removal was appreciable when

Removal of BMR by Adsorption on

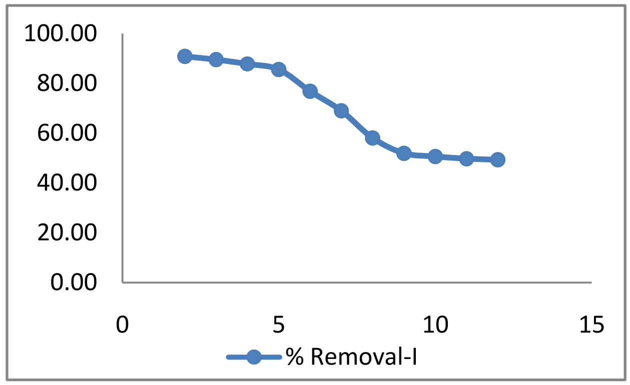


Fig. 1. Effect of pH on adsorption of BMR. Concentartion of solution: 100mg/l, mass of carbon :.75mg Temperature room temperature.

It was clear that the dye uptakes were much higher in acidic solutions than those in neutral and alkaline conditions.

The possible reason for such type of behaviour is due to the fact that the adsorbent was positively charged. As initial pH of the test solution increased, the number of negatively charged adsorbent sites increased. and positively charged adsorbent sites favoured the adsorption of dye due to electrostatic attraction. Similar result was reported by Yoshida et al. [31] and Hameed et al. [32]

### 3.2Effect of adsorbent dose

The effect of sorbent dose on the removal of the dye was shown in Fig. 2 The percentage of the dye adsorbed increased as the adsorbent dose was increased over the range, 5 -2.5g. The adsorption of the dye increased from 85% to 95% with the increase in sorbent dose. This observation is consistent with Langmuir hypothesis of an increasing competition among adsorbent particles for organic substances with increasing number of adsorbent particles per unit volume [33,34].

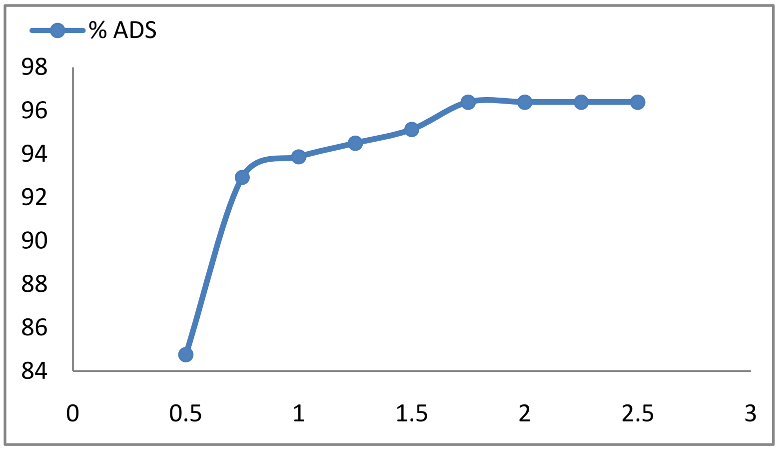


Fig. 2. Effect of variation of amount of adsorbent on adsorption of the dye, BMR
Concentration of solution:100 mg/l pH: solution pH,

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### 3.3 Adsorption Isotherms

In order to choose the best isotherm model to represent BMR adsorption system, a set of equilibrium data has been tested on the Langmuir, Freundlich, and Temkin

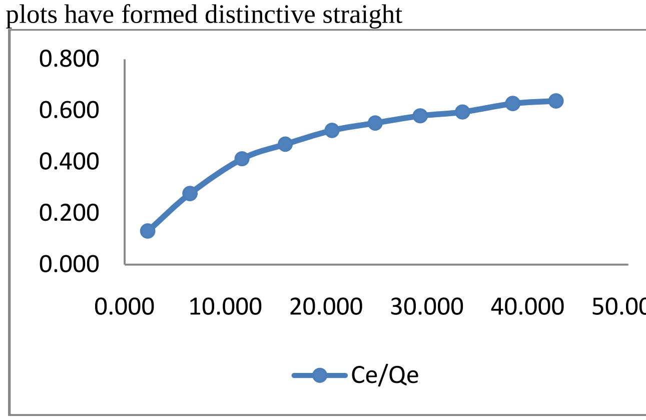
$$q_e = Q_m K_L C_e /(1 + K_L C_e)$$

$$q_e = K_F C_e^{1/n}$$

$$q_e = \beta \ln K_T C_e$$

isotherm models, respectively, where $q_e$ is the adsorption capacity in equilibrium (mg g-1), $C_e$ is the sorbate equilibrium concentration (mg L-1), $K_L$ (L mg-1) is the Langmuir constant associated to energy of adsorption and $Q_m$ denotes the theoretical monolayer adsorption capacity (mg g-1). $K_F$ is the Freundlich constant (mg g-1)(L mg-1)1/n while 1/n represents dimensionless heterogeneity factor. β is the Temkin constant related to heat of adsorption (kJ mol-1). $T$ $K$ is the equilibrium binding constant (L/mol-1) corresponding to the maximum binding energy.

Figures 3,4 and 5 illustrate the Langmuir, Freundlich andTemkin plots for the removal of brown MR dye. The linear plots have formed distinctive straight



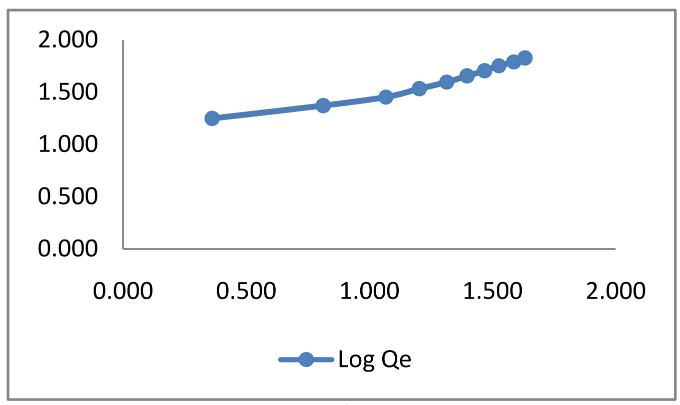




Fig. 3. Langmuir isotherm plot for BMR
(2)

Fig.4 Freundlich isotherm plot for BMR
(3)

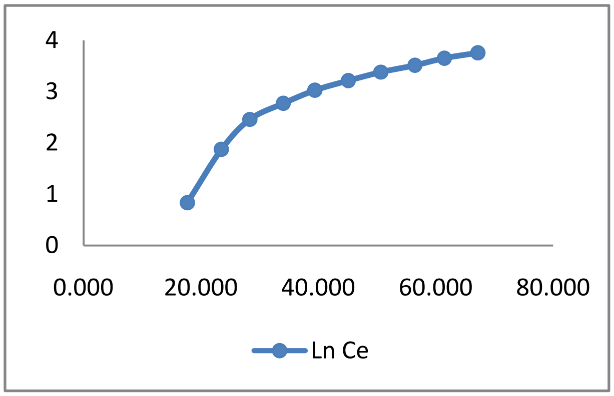



Fig.5 Temkin isotherm plot for BMR

The correlation coefficient ($R^2$) for Langmuir, Freundlich and Temkin isotherms were 0.846, 0.998, 0.771 respectively. From the correlation coefficient value it was concluded that Freundlich isotherm fitted well compare to other isotherm.

**4. Conclusion.**

The result obtained from the present investigation confirmed that activated carbon prepared from Langeria Siceraria seed hull was excellent and economical adsorbent for the removal of direct dye Brown MR from the aqueous solution. The maximum adsorption observed below when the solution pH was 4, the mass of carbon was 1g . The dye obeyed Freundlich isotherm.

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